SB761
U7N6
#82-5

United States
Department of
Agriculture

Forest
Service

Northern
Region

State &
Private
Forestry

Report No. 82-5

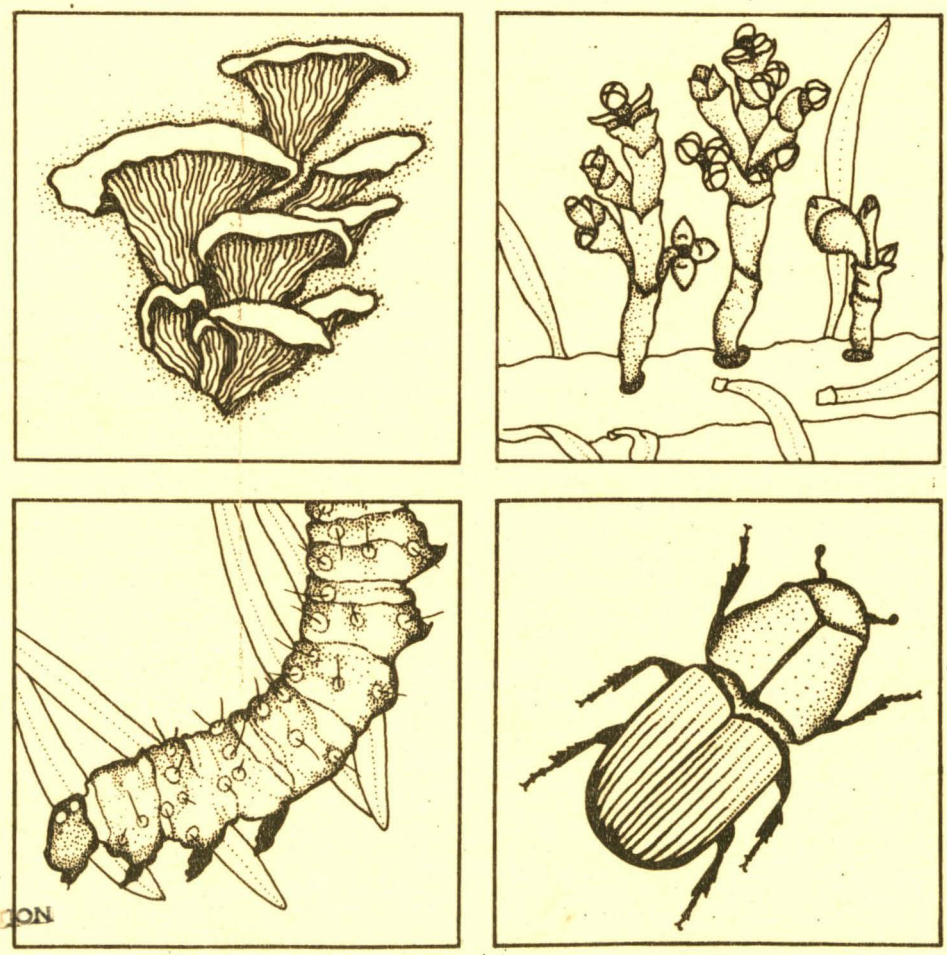
June 1982

Forest Pest Management

AN EVALUATION OF CONE AND SEED INSECTS IN SELECTED SEED PRODUCTION AREAS IN REGION ONE (Final Report)

by

Jerald E. Dewey
Michael J. Jenkins



LIBRARY
MAY 9 1983
ROCKY MOUNTAIN REGION

AN EVALUATION OF CONE AND SEED INSECTS IN SELECTED SEED PRODUCTION AREAS IN REGION ONE (Final Report)

by

Jerald E. Dewey and Michael J. Jenkins [1/]

INTRODUCTION

Demands for, and pressures on, forest resouces have been increasing steadily for many years. Projected needs for all forest resources are substantially above levels that can be supplied with present management programs (USDA-Forest Service 1977). A 65 percent rise in the use of timber products has occurred in the U.S. during the past 3 decades (USDA-Forest Service 1974).

Intensified forest management offers an important means of increasing timber supplies in the long run while maintaining an acceptable forest environment. This includes expanded tree planting, stand improvement, protection, and other forestry practices. Most forest areas are not fully stocked with desirable timber and are growing at a much lower rate than is possible under intensified management (USDA-Forest Service 1974).

In spite of projected demands for timber products, changing environmental and economic conditions indicate that the base area providing these products will continue to shrink. To help increase production on a decreasing timber base, Region 1 is directing much effort to more effective regeneration using improved trees. The primary seed sources for such trees are seed production areas (SPA)--phenotypically superior trees in natural stands--and seed orchards (SO) consisting of genetically improved trees located outside natural stands. Large quantities of nursery stock are needed annually to regenerate harvested, burned, and other understocked areas. In 1980, the Region's nursery in Coeur d'Alene, Idaho shipped 17.7 million seedlings for planting in Region 1, other Regions, and for use by other agencies. In 1980, in Region 1 alone, 58,010 acres were planted with seedlings and another 242 acres were directly seeded (USDA-Forest Service 1980).

1/ Respectively, Supervisory Entomologist, USDA-Forest Service, State and Private Forestry, Missoula, MT; Graduate Student, Utah State Univ., Logan, UT

To date about 70 SPA's and six SO's are planned or established in the Region. All Forests except the Custer are represented. Thirty-eight SPA's encompassing almost 2,000 acres (range 1-248 acres), and six SO's encompassing 87 acres (range 8-28 acres) are currently established on seven Forests.

Many species of insects are known to damage cones and seeds of western conifers (Keen 1958). Numerous studies have documented significant impacts on cone production by a number of insect species (Barnes et al. 1962; Hedlin 1967a; Hedlin 1967b; Fellin and Shearer 1968; Dewey 1970; Hedlin 1973; Kulhavy and Schenk 1973; and Hedlin et al. 1980). Entire cone crops can be lost to insects if control measures are not taken. Thus, in order to insure that SPA's and SO's realize their intent, attention must be given to insect pests.

Presently few alternatives exist for management of western SPA's and SO's. The sequence of events preceding development of control practices are (1) precise identification of insect pests, (2) assessment of impact caused by those pests singly or working together, and (3) a cost/benefit analysis of the management alternatives. When pests causing significant impact have been identified, management alternatives should be evaluated. If alternatives are nonexistent or inadequate, research should be initiated towards their development.

In 1978 we initiated an SPA/SO seed and cone insect survey with the following objectives:

1. Determine the primary cone- and seed-feeding insects on a host basis at each existing and planned seed production area in the Region.

2. Describe the type, and quantify the amount of injury caused by each insect species.

3. Where possible, correlate the extent of cone and seed injury with such factors as habitat type, elevation, stand age, and stocking density.

Our original intent was to monitor the Region's SPA's and SO's until all areas and all tree species had been sampled during years of light, moderate, and heavy cone production. This amount of sampling was considered necessary because the extent and frequency of insect damage to cones and seeds can vary substantially from year to year depending on cone crop size, climatic conditions, surrounding pest population densities, and complexes of predators, parasites, and pathogens.

This survey was designed to provide SPA and SO managers with a general appreciation of the primary pests present on a tree species and area basis. It was also our intent to show anticipated cone and seed losses

occurring without management. Funding and manpower constraints forced termination of this survey at the end of the third year. Progress reports of the first 2 years of the survey were published earlier (Dewey and Jenkins 1979; Dewey and Jenkins 1980).

METHODS

The following data were collected for each SPA and SO: elevation, habitat type, aspect, slope, tree species managed for, stand age, stand density, and special treatments applied (fertilization, roguing, thinning, etc.). In May or early June of each year the areas were examined to determine if sufficient cones were present for collection. Areas with ample cones were revisited and collections made at approximately 3- to 4-week intervals from June through mid-September.

When sufficient cones were available, four trees of each species were marked and sampled throughout the summer. If cone numbers were inadequate to provide a full sample from the four trees, the remaining cones were collected from the nearest cone-bearing trees.

Each sample tree was divided into directional quadrants (north, south, east, and west). The most accessible cones from within or nearest a given quadrant were collected without consideration to cone condition. A different quadrant was sampled at each collection period. Directional quadrants were used to minimize variability between number and species of insects that may occur. No attempt was made to treat data separately by quadrant.

The cone population was estimated on each sample tree using binoculars and/or a spotting scope. Cone crops were defined as very light, light, moderate, or heavy using Dobbs et al. (1976) method.

When sufficient cones were available, 40 were collected and stored in paper bags marked as to location, date, tree species, tree number, and collector. Collections were placed in chest type coolers and returned to the lab. In the laboratory, one-half (20) of the cones per bag were dissected, and the other half were placed in rearing containers to obtain adult insects for identification.

Cones were collected by climbing trees, pruning cone-bearing branch tips using a telescopic pole pruner with catch basket attached, and/or shooting cone-bearing branches from trees.

Prior to dissecting cones in the lab an external examination was made to estimate the amount of injury. Criteria used to assess injury were excessive resin exudation, distorted shape, or other evidence of insect feeding. Each cone was assigned one of the following codes:

Code number		Percent of cone injured
1	=	0
2	=	1-10
3	=	11-25
4	=	26-50
5	=	51-75
6	=	76-100

Following estimation of injury, cones were dissected and completely examined to determine if insects were present. Where possible, an identification was made. Larvae obtained from dissections were placed in one of the following categories: western spruce budworm 2/, midges 3/, cone moth 4/, coneworms 5/, seed chalcids 6/, cone maggots 7/, mountain pine cone beetle 8/, and miscellaneous.

The "injury rating" for each plot and each collection was calculated by summing the individual cone ratings and dividing by the total number of cones in the sample.

Adult insects obtained from rearing containers were sent to the U.S. National Museum for identification.

RESULTS

During the 3 years of the survey, cone collections were made from 65 SPA's 9/ and one SO. Insufficient cones prevented collections from each area each year.

Collection records and individual SPA data are displayed in the Appendix.

2/ Choristoneura occidentalis Freeman (Lepidoptera: Tortricidae)
3/ Contarinia sp. and unknown sp. (Diptera: Cecidomyiidae)
4/ Barbara colfaxiana Kearf. (Lepidoptera: Olethreutidae)
5/ Dioryctria sp. (Lepidoptera: Pyralidae)
6/ Megastigmus sp. (Hymenoptera: Torymidae)
7/ Earomyia sp. (Diptera: Lonchaeidae)
8/ Conophthorus monticolae Hopkins (Coleoptera: Scolytidae)
9/ Each tree species is considered a separate SPA

Collections were made 1 year at 37 areas, 2 years at 20 areas, and all 3 years at eight areas. No collections were made from lodgepole pine SPA's in 1980 because the injury observed to this species during the previous 2 years was minimal.

During the survey, collections were made from 23 Douglas-fir, 12 lodgepole pine, 10 western larch, seven ponderosa pine, four western white pine, three grand fir, three Engelmann spruce, one western hemlock, and one subalpine fir SPA.

SPA's were sampled on 11 National Forests and on one BLM area. Forest and number of SPA's sampled were:

Beaverhead	(4)	Idaho Panhandle	(8)
Bitterroot	(10)	Kootenai	(8)
Clearwater	(8)	Lewis & Clark	(3)
Deerlodge	(3)	Lolo	(6)
Flathead	(8)	Nezperce	(2)
Helena	(4)	BLM	(2)

In general cone crop size in the SPA's sampled was light to moderate in 1978; light in 1979; and moderate to heavy in 1980. Variation between tree species and SPA's occurred during each year.

Overall cone injury was low during the first collection period, increasing through August and declining somewhat in September. This is illustrated for Douglas-fir in table 1. This pattern is attributed to increased injury with time as different species of cone pests appear. Injury declines in September because the more severely damaged cones are shed prior to the final collection.

Table 1.--Douglas-fir cone injury by collection period.

Collection period	Injury rating
1	1.4
2	2.0
3	1.9
4	2.0
5	2.4
6	2.6
7	2.1

As expected, the amount of injury was related to cone crop size during the current and previous year. The smaller the crop the greater the damage. Small crops following large crops are especially prone to high injury levels. Table 2 shows this relationship for western white pine from the Sandpoint Seed Orchard and for Douglas-fir.

Table 2.--Cone injury versus cone crop size

Western white pine

Cone crop size	Injury rating
Medium (1978)	4.5
Light (1979)	5.9
Heavy (1980)	.0

Douglas-fir

Cone crop size	Injury rating
Light	2.6
Light to moderate	2.1
Moderate to heavy	1.8

Extent of cone injury varied with the Forest where collections were made (table 3).

Table 3.--Douglas-fir cone injury by Forest

Forest	Injury rating
Beaverhead	3.23
Bitterroot	2.15
Clearwater	1.20
Deerlodge	2.53
Flathead	1.59
Helena	2.81
Idaho Panhandle	2.09
Kootenai	1.65
Lolo	2.05

The three National Forests east of the Continental Divide, i.e. Beaverhead, Deerlodge, Helena, had the highest damage ratings for Douglas-fir. This is the area in the Region where western spruce budworm populations are highest.

Individual plot data is shown in Appendix.

DISCUSSION

All the objectives of the planned survey were not met because it was discontinued after 3 years. Some SPA's failed to produce cones during the survey. Most areas producing cones had only light and/or moderate sized cone crops. Insufficient data were collected to establish relationships between cone injury and habitat type, stand age, stocking density, and/or elevation.

Cone and seed insect damage is highly variable. Cone crop size during the current and previous years, proximity to western spruce budworm epidemics, and climatic conditions during the period of egg laying and larval dispersal can all influence insect populations and cone injury. Also topographic characteristics including elevation, exposure, stand composition, and stand age may be of importance. Thus, considerable variation was expected in the amount and type of injury observed within a given tree species from area to area and year to year.

The following summarizes our findings for each tree species:

Douglas-Fir

This species is a preferred host for many cone and seed feeding insects. The primary pest(s) varies with the SPA and collection date. Western spruce budworm was the most important insect encountered being especially damaging on those Forests with active epidemics, i.e. Deerlodge, Beaverhead, and Helena. It is also very damaging to cones on other Forests having a history of budworm outbreaks, i.e. Bitteroot, Lolo, and Clearwater. Budworm was less important on Forests where it seldom occurs as a serious defoliator, i.e. Flathead, Kootenai, and Idaho Panhandle. Budworm feeds on cones early in their development making initial attacks as newly emerged larvae in the spring. Budworm attack and often kill the conelets shortly after buds burst and continue feeding on cones and foliage throughout their larval stage until about mid-July.

Two midges, the Douglas-fir cone midge and the Douglas-fir scale midge, are widespread and abundant on all Forests. Larvae are present in cones throughout most of the cone's development, becoming conspicuous when nearly mature larvae turn orange or pink in color. Often 30 or more larvae infest a single cone but damage is quite subtle. Some seeds are fed on and destroyed; other seeds are trapped in the cone by galls or resin and cannot be extracted. Seed viability may be reduced due to the weakened condition of the cone.

The Douglas-fir cone moth was found on most Forests, but was most damaging in northern Idaho and northwestern Montana. Several larvae are usually present in infested cones, tunneling through scales and seeds. Externally, damage is recognized by resinous frass at the entrance hole. Little viable seed is collected from cone moth-infested cones.

Two species of coneworms were found throughout the Region. They were the most damaging pests in some areas during some collection periods.

Seed chalcids, maggots, and other lepidopterous larvae were quite common but relatively unimportant.

Western Larch

Western larch cones were only lightly to moderately damaged during this survey. Four insect species accounted for most of the damage. These were (1) an unidentified midge; (2) a cone maggot; (3) a coneworm; and (4) the western spruce budworm.

Insect feeding on developing larch cones often retarded growth resulting in small, woody cones with few if any fully developed seed.

Lodgepole Pine

Thirteen lodgepole pine SPA's scattered throughout the Region were sampled during 1978 and 1979. In each case cone damage by insects was very light. This finding caused us to discontinue sampling lodgepole pine SPA's in 1980. The small amount of injury observed resulted from coneworms and midges.

Western White Pine

The primary pest of western white pine in the areas surveyed was the mountain pine cone beetle. It destroyed many second year cones especially during years of light and moderate cone crops. Adult beetles attack developing second-year cones in the spring killing them by severing conductive tissues in the cone axis. Dissected cones revealed numerous larvae, pupae or adults of typical scolytid appearance.

A less important pest of white pine was a coneworm.

Ponderosa Pine

Ponderosa pine cone crops were sparse during the survey. Only six SPA's produced enough cones to sample and most of those had sufficient cones for only one or two collections.

Two species of coneworms were prevalent in some areas. Midges were also found frequently during cone dissection, but were few in number and apparently of little concern.

REFERENCES CITED

Barnes, Burton V.; Bingham, R. T.; Schenk, John A. Insect-caused loss to western white pine cones. Research Note 102, Intermountain Forest and Range Expt. Sta., Ogden, UT. 1962.

Dewey, Jerald E. Damage to Douglas-fir cones by Choristoneura occidentalis. J. Econ. Ent., Vol. 63, No. 6. 1970.

Dewey, Jerald E.; Jenkins, Michael J. An evaluation of cone and seed insects in selected seed production areas in Region 1 (Progress Report). USDA-Forest Service, Forest Insect and Disease Management, Report 79-16. 1979.

Dewey, Jerald E.; Jenkins, Michael J. An evaluation of cone and seed insects in selected seed production areas in Region 1 (Progress Report II). USDA-Forest Service, Forest Insect and Disease Management, Report 80-18. 1980.

Dobbs, R. D.; Edwards, G. W.; Konishi, J.; Wallinger, D. Guidelines to collecting cones of British Columbia conifers. British Columbia Forest Serv./Can. Forestry Serv. Joint Report No. 3. 1976.

Fellin, D. G.; Shearer, R. C. Spruce budworm larvae damage western larch cones and seeds. J. Forestry 66(7): 568-570. 1968.

Hedlin, A. F. Cone insects of grand fir, Abies grandis (Douglas) Lindley, in British Columbia. J. Ent. Soc. of B.C., Vol. 64. 1967a.

Hedlin, A. F. The pine seedworm, Laspeyresia piperana (Lepidoptera: Olethreutidae), cones in ponderosa pine. The Can. Ent., Vol. 99, No. 3. 1967b.

Hedlin, A. F. Spruce cone insects in British Columbia and their control. The Can. Ent., Vol. 105. 1973.

Hedlin, Alan F.; Yates, Harry O., III; Tovar, David Cibrian; Ebel, Bernard H.; Koerber, Thomas W.; Merkel, Edward P. Cone and seed insects of North American conifers. Can. For. Serv., USDA-Forest Service. 1980.

Keen, F. P. Cone and seed insects of western forest trees. U. S. Dept. Agric. Tech. Bull. 1169. 1958.

Kulhavy, D. L.; Schenk, J. A. A damage appraisal of cone and seed insects of alpine fir in northern Idaho. Proc. Wash. State Ent. Soc. 34: 364. 1973.

USDA-Forest Service. The outlook for timber in the United States. USDA-Forest Service. Forest Resource Report-20. 1974.

USDA-Forest Service. The nation's renewable resources - an assessment, 1975. USDA-Forest Service. Forest Resource Report-21. 1977.

USDA-Forest Service. Annual silvicultural accomplishment report, fiscal year 1980, Region 1. USDA-Forest Service (In-Service Report). Timber Management. Missoula, Montana. 1980.

APPENDIX

Collection period [1]	Forest, SPA & tree species	1978 injury rating	1978 [2] primary pests	1979 injury rating	1979 primary pests	1980 injury rating	1980 primary pests
	BEAVERHEAD NF	No collections				No collections	
4	Elkhorn #1			1.1	Unknown		
7	LPP			1.1	Unknown		
				Cone crop size = L			
4	Elkhorn #2	No collections				No collections	
	LPP			1.2	Unknown		
				Cone crop size = L			
7	Upper Prairie Cr.	No collections				No collections	
	LPP			1.3	Unknown		
				Cone crop size = L			
2	Cat Cr.	No collections		No collections		3.4	1(100%)
3	DF					3.3	1(94%) 5(6%)
6						3.0	1(58%) 2(52%)
						Cone crop size = L	
	BITTERROOT NF						
2	Big Cr.	No collections				1.2	5(100%)
3	PP			3.7	5(100%)		
6						1.4	5(67%) 2(17%)
				Cone crop size = VL		Cone crop size = L	

1/ Collection Periods
- 1 = 6/1 - 6/15
- 2 = 6/15 - 6/30
- 3 = 7/1 - 7/15
- 4 = 7/16 - 7/31
- 5 - 8/1 - 8/15
- 6 = 8/16 - 8/31
- 7 = 9/1 - 9/15

2/ Primary pests
- 1 = Western spruce budworm
- 2 = Cone midges
- 3 = Scale midges
- 4 = Douglas-fir cone moth
- 5 = Coneworm
- 6 = Seed chalcid
- 7 = Cone maggot
- 8 = Miscellaneous
- 9 = Mountain pine cone beetle

Collection period [1]	Forest, SPA & tree species	1978 injury rating	1978 [2] primary pests	1979 injury rating	1979 primary pests	1980 injury rating	1980 primary pests
2	Buck Cr.	-		1.2	Unknown		
3	LPP	-		1.0	-	No collections	
4		1.1	Unknown	-			
5		1.1	3(100%)	1.0	-		
6		1.4	3(100%)	1.4	5(67%) 2(33%)		
		Cone crop size = M		Cone crop size = M			
1	Eight Mile Cr.	-		-		1.0	-
2	DF	-		1.9	1(83%) 4(14%)	-	
3		-		2.5	4(89%) 1(11%)	-	
4		2.5	1(71%) 5(24%)	-	-	1.4	1(89%) 4(11%)
5		1.7	1(77%) 4(19%)	3.7	5(73%) 4(24%)	-	
6		2.2	1(40%) 2,3(33%)	2.1	5(85%)	1.8	5(82%) 1(18%)
7		2.0	Unknown	-		-	
		Cone crop size = M		Cone crop size = L		Cone crop size = M	
2	Slocum/Claremont Cr.	-	-	1.1	Unknown		
3	LPP	-	-	1.1	Unknown	No collections	
4		1.2	Unknown	-			
5		1.2	3(64%)	1.1	Unknown		
6		Cone crop size = M		1.1	5(100%)		
				Cone crop size = M			
1		-	-	-		1.0	Unknown
2	So. Ambrose	-	-	1.1	1(100%)	-	
3	WL	-	-	1.2	1(50%) 3(50%)	-	
4		1.8	2(53%) 8(24%)	-		1.0	3(100%)
5		1.5	2(71%) 8(21%)	1.4	5(67%) 8(20%)	-	
6		3.8	2(100%)	1.4	Unknown	1.7	1(100%)
7		1.8	Unknown	-		-	
		Cone crop size = VL		Cone crop size = M		Cone crop size = M	

Collection period [1]	Forest, SPA & tree species	1978 injury rating	1978 [2] primary pests	1979 injury rating	1979 primary pests	1980 injury rating	1980 primary pests
2	Wheeler Cr.	-	-	1.6	8(78%) 5(22%)	1.2	Unknown
3	PP	-	-	1.8	5(100%)	-	
4		-	-	-		3.2	5(92%)
5		1.1	8(75%) 3(25%)	2.2	5(30%) 8,7(20%)	-	
6		2.0	3(50%) 5,7(25%)	1.6	5(75%)	4.9	5(100%)
		Cone crop size = M		Cone crop size = L		Cone crop size = M	
2	Soda Springs Cr.	No collections		No collections		1.5	1(86%) 5(19%)
4	DF					1.5	1(80%) 4(20%)
6						2.3	5(83%) 3(11%)
						Cone crop size = L-M	
2	Lower Ditch Cr.					2.8	1(97%)
4	DF	No collections		No collections		2.8	1(100%)
						2.9	1(34%) 5(67%)
						Cone crop size = L	
4	Signal Cr.	No collections		No collections		1.2	2(100%)
	ES					Cone crop size = H	
2	Eastman Cr.	No collections		No collections		1.3	1(100%)
	ES					Cone crop size = H	
	CLEARWATER NF						
3	Bertha Hill	No collections		-	-	1.4	9(100%)
5	WWP			2.0	5(22%) 9(56%)	1.2	8(66%) 9(33%)
6				1.8	5(100%)	-	-
				Cone crop size = ?		Cone crop size = M	

Collection period [1]	Forest, SPA & tree species	1978 injury rating	1978 [2] primary pests	1979 injury rating	1979 primary pests	1980 injury rating	1980 primary pests
3 6	Jungle Point DF	No collections		No collections		1.1 1.3 Cone crop size = M	1(100%) 2(100%)
3 6	Jungle Point GF	No collections		No collections		1.3 2.4 Cone crop size = H	5(100%) 5(86%)
5 6	McGary Cr. WL	No collections		2.3 2.7 Cone crop size = VL	8(90%) 2,3(10%) 2(50%) 5(50%)	No collections	
6	Packer Meadows LPP	No collections		1.0 Cone crop size = ?	Unknown	No collections	
3 6	Pete Cr. WWP	No collections		No collections		1.0 1.2 Cone crop size = M	Unknown 8(100%)
1 4 5	Powder House Cr. WWP	No collections		1.9 1.0 1.2 Cone crop size = ?	9(100%) Unknown 5(100%)	No collections	
4 6	Savage Camp WL	No collections		1.5 1.4 1.8 Cone crop size = L	8(63%) 2(37%) 3(83%) 5(17%) 2,5,8(50%)	No collections	

Collection period [1]	Forest, SPA & tree species	1978 injury rating	1978 [2] primary pests	1979 injury rating	1979 primary pests	1980 injury rating	1980 primary pests
2	DEERLODGE NF	No collections		No collections		1.4	1(100%)
4	Basin Cr.					1.8	1(100%)
6	DF					3.75	2(65%) 7(11%)
						Cone crop size = M	
2	Black Pine	No collections				1.4	1(100%) 5(28%)
3	DF			1.2	1(100%)	3.0	1(94%)
4				2.4	4(97%)		
6				3.1	4(53%)	4.4	2(32%) 1,5(28%)
7				3.5	5(40%) 2(53%)		
				Cone crop size = L		Cone crop size = M	
2	Blodgett Gulch	No collections		No collections		2.6	1(100%)
4	DF					2.1	1(40%) 8(35%)
6						2.8	2(57%) 1(27%)
						Cone crop size = L	
1	FLATHEAD NF			No collections		1.2	1(100%)
3	Bond Cr.	1.2	1(71%)				
4	DF					1.3	4(56%) 8(44%)
5		2.0	3(49%) 4(47%)			1.2	5(66%) 2(34%)
6		2.6	3(61%) 4(24%)				
7		1.3	3(66%) 5(33%)				
		Cone crop size = M				Cone crop size = M	
1	Coram					1.1	Unknown
2	WL	No collections		1.1	8(100%)		
4				1.7	1(90%) 3(40%)	3.0	2(62%) 8(38%)
5				1.1	1(71%) 8(29%)	2.6	1(100%)
				Cone crop size = M		Cone crop size = M	
4	Emery Cr.	No collections		2.3	4(96%)	No collections	
	DF						
				Cone crop size = ?			

Collection period [1]	Forest, SPA & tree species	1978 injury rating	1978 [2] primary pests	1979 injury rating	1979 primary pests	1980 injury rating	1980 primary pests
1				No collections		1.0	8(100%)
3	Lid Cr.					2.3	8(100%)
5	WL					5.8	1(100%)
6		1.0	Unknown				
		Cone crop size = L				Cone crop size = L	
1	Mount Cr.			1.7	7(100%)	1.4	7(100%)
2	WL			1.3	7(100%)		
3						1.9	1(92%)
4				1.1	8(100%)		
5				2.1	3(91%) 8(13%)		
6		1.6	2(100%)	1.2	Unknown		
7		1.5	Unknown				
		Cone crop size = VL		Cone crop size = L		Cone crop size = M	
1	Mount Cr.	No collections		No collections		1.1	Unknown
3	DF					1.2	8(100%)
						Cone crop size = ?	
1	Wolf Cr.			No collections		1.2	1(100%)
3	DF	1.9	1(77%) 5(13%)				
4						1.4	4(71%) 8(29%)
5						1.8	5(89%) 8(11%)
6		2.3	3(85%)				
7		1.4	Unknown				
		Cone crop size = M				Cone crop size = M	
1	Wolf Cr.			No collections		1.2	5(100%)
3	PP	1.6	8(62%) 5(38%)				
4						2.2	5(91%) 8(59%)
5		1.4	8(77%) 5(23%)				
6		1.3	Unknown				
7		1.3	Unknown				
		Cone crop size = M				Cone crop size = VL	

Collection period [1]	Forest, SPA & tree species	1978 injury rating	1978 [2] primary pests	1979 injury rating	1979 primary pests	1980 injury rating	1980 primary pests
	HELENA NF						
2	Chimney Cr.	No collections		2.5	1(97%)		
3	DF					2.3	1(54%) 5(45%)
5				3.5	5(100%) 4(13%)	1.9	1(65%) 4(30%)
6				4.6	5(51%) 2(19%)		
7						2.2	5(58%) 2,4(17%)
				Cone crop size = L		Cone crop size = M	
2		1.1	Unknown	1.0	Unknown	No collections	
3	Colorado Mtn.			1.3	5(75%) 8(25%)		
4	LPP	1.4	8(100%)	1.5	8(100%) 5(14%)		
6				1.2	5(100%)		
7		1.0	Unknown				
		Cone crop size = M		Cone crop size = M			
3	Coopers Lake			1.0	7(100%)	4.6	Unknown
4	WL	2.4	8(100%)				
5				1.1	5(75%)	1.8	1(100%)
6		2.9	5(10%)(90%) Unknown	1.1	2(86%) 7,8(14%)	2.3	1(80%) 8(20%)
7		1.1	Unknown				
		Cone crop size = VL		Cone crop size = L		Cone crop size = M	
2	McQuithy Gu.	No collections		1.7	1(100%)	No collections	
3	DF			2.2	1(92%)		
4				3.4	5(88%) 8(19%)		
6				3.8	2(52%) 5(39%)		
				Cone crop size = L			
3	IDAHO PANHANDLE	No collections		1.3	8(100%)		
4	Cathedral Pk.					1.1	8(66%) 5(34%)
7	WWP					2.3	9(100%)
				Cone crop size = M		Cone crop size = L-M	

Collection period [1]	Forest, SPA & tree species	1978 injury rating	1978 [2] primary pests	1979 injury rating	1979 primary pests	1980 injury rating	1980 primary pests
3	Halfway Pk.	No collections		1.3	8(100%)	1.0	Unknown
6	WH					1.1	2(100%)
				Cone crop size = M		Cone crop size = H	
3	Halfway Pk.	No collections		1.3	8(100%)	No collections	
	LPP			Cone crop size = M			
3	Halfway Pk.	No collections		No collections		1.0	7(100%)
6	SAF					1.0	Unknown
						Cone crop size = M	
3		No collections		No collections		1.0	Unknown
6	Halfway Pk.					1.0	Unknown
	ES					Cone crop size = M	
2	Kelly Mt.			2.3	4(100%)	1.3	1(100%)
3	DF	3.0	1(60%) 5(32%)				
5		4.6	1(55%) 2(39%)			1.8	5(100%)
6		1.5	2(73%) 3(18%)				
		Cone crop size = L		Cone crop size = VL		Cone crop size = M	
2	Kelly Mt.	No collections		No collections		1.1	1(100%)
5	GF					2.1	8(60%) 5(40%)
						Cone crop size = M	
	Sandpoint SO	4.5	9(100%)	5.9	9(100%)	.0	9(100%)
	WWP	Cone crop size = M		Cone crop size = L		Cone crop size = H	

Collection period [1]	Forest, SPA & tree species	1978 injury rating	1978 [2] primary pests	1979 injury rating	1979 primary pests	1980 injury rating	1980 primary pests
3	Spyglass	No collections		No collections		1.1	1(100%)
6	DF					1.1	2(100%)
						Cone crop size = M	
1	KOOTENAI NF					1.0	1(100%)
2	Bristow Cr.	1.1	1(71%) 5(57%)	1.8	4(100%)		
3	DF					1.2	8(100%)
4		1.3	2(70%) 1(35%)	2.4	4(100%) 5(14%)		
5		1.8	2,3(86%) 4(29%)	4.3	5(100%)	1.8	5(67%) 2(33%)
7		1.7	3(100%)				
		Cone crop size = M		Cone crop size = VL		Cone crop size = M	
2	Bristow Cr. PP	No collections		2.0	5(70%) 3(20%)	No collections	
				Cone crop size = ?			
2	Coyote Flat PP	2.5	5(100%)	No collections		No collections	
		Cone crop size = M					
4	Coyote Flat LPP	1.0	8(100%)	No collections		No collections	
		Cone crop size = ?					
2		1.0	5(100%)	1.2	3(100%)	No collections	
5	Fisher Cr.	1.0	Unknown	1.2	3(100%)		
6	LPP			1.8	2(100%)		
7		1.0	Unknown				
		Cone crop size = L		Cone crop size = L			

Collection period [1]	Forest, SPA & tree species	1978 injury rating	1978 [2] primary pests	1979 injury rating	1979 primary pests	1980 injury rating	1980 primary pests
3	Pony Mt.	No collections		No collections		1.4	8(38%) 2(25%) 4(38%)
5	DF					1.3	2(82%) 5(18%)
						Cone crop size = M	
1	Tamarack, Deer Gu.	No collections		No collections		1.1	Unknown
4	DF					1.1	2(71%)
5						1.4	5(100%)
						Cone crop size = M	
6	Rocky Cr. PP	1.0	Unknown	No collections		No collections	
		Cone crop size = ?					
	LEWIS & CLARK NF						
2	Moose Cr.			1.0	Unknown	No collections	
6	LPP	1.0	Unknown	1.1	2(50%) 5(50%) 7(50%)		
		Cone crop size = ?		Cone crop size = M			
2	Moose Park	1.0	Unknown	No collections		No collections	
4	LPP	1.2	8(100%)				
5		1.0	1(50%) 8(50%)				
7		1.0	Unknown				
		Cone crop size = ?					
1	LOLO NF	No collections				1.2	1(100%)
3	C. C. Divide			1.3	4(42%) 1(58%)		
4	DF			1.8	5(42%) 1(58%)	1.2	1(14%) 8(86%)
5				1.9	5(70%) 8(30%)		
				Cone crop size = L		Cone crop size = M	
	C. C. Divide	No collections		No collections			
1	WL					1.1	1(100%)
4						Cone crop size = VL	

Collection period [1]	Forest, SPA & tree species	1978 injury rating	1978 [2] primary pests	1979 injury rating	1979 primary pests	1980 injury rating	1980 primary pests
1				No collections		2.3	1(90%)
3	Henry Cr.	2.8	1(100%)				
4	DF					1.8	4(66%) 5(32%)
		Cone crop size = M				Cone crop size = M	
1	Henry Cr.			3.0	1(100%)	1.4	7(100%)
3	WL	2.7	8(100%)	1.7	1(100%)		
4				1.3	1(100%) 3(17%)	2.1	1(100%)
5				1.5	1(85%) 8(15%)		
6		1.9	2(75%) 3(25%)				
		Cone crop size = VL		Cone crop size = L		Cone crop size = M	
1	Henry Cr.			1.2	8(100%)	No collections	
3	PP	2.0	5(73%) 8(27%)	2.4	5(100%)		
4				2.3	5(92%)		
5				5.0	5(100%) 8(13%)		
6		2.8	5(82%) 3(24%)				
		Cone crop size = M		Cone crop size = L			
1	Lower Radio Cr.	No collections		1.1	7(50%) 8(50%)	No collections	
3	WL			1.2	8(60%) 1(40%)		
4				1.5	1(67%) 2(33%)		
5				1.1	2(50%) 5(50%)		
				Cone crop size = L			
	NEZPERCE NF						
3	Potato Hill	1.3	8(64%) 5(36%)	No collections		1.3	4(50%) 1(37%)
5	GF	2.2	4(100%)				
6		1.9	1(57%) 5(29%)			2.5	5(81%) 2(27%)
		Cone crop size = H				Cone crop size = H	

Collection period 1/	Forest, SPA & tree species	1978 injury rating	1978 2/ primary pests	1979 injury rating	1979 primary pests	1980 injury rating	1980 primary pests
	BLM						
4	Union Pk.	1.8	1(100%)	No collections		No collections	
6	DF	2.0	1(100%)				
		Cone crop size = ?					
1	Coloma	2.5	1(92%) 3(18%)	No collections		No collections	
3	DF	2.9	1(62%) 5(38%)				
5		2.6	1(70%) 4(30%)				
		Cone crop size = M					